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Technical Report ARMET-TR-09015

FIVE-SECOND EXPLOSION TEMPERATURE (U.S. ARMY ARDEC METHOD) USERS MANUAL

Theodore Dolch
Neha Mehta
Eugene Homentowski

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ENGINEERING CENTER**

Munitions Engineering Technology Center

Picatinny Arsenal, New Jersey

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14. ABSTRACT The 5-sec explosion temperature test was developed at the U.S. Army Armament Research, Development and Engineering Center (ARDEC), Picatinny Arsenal, New Jersey. This ARDEC method is a thermal test used to determine the 5-sec time-to-explosion temperature of an energetic material. This test is required for Final Hazard Classification (FHC) of an energetic material used in the U.S. Army end items. This test was described in MIL-STD-650, Method T 515.1, dated 28 September 1987. MIL-STD-650 is now obsolete. This technical report will serve as a reference for this test method.					
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INTRODUCTION

The 5-sec explosion temperature test [U.S. Army Armament Research, Development and Engineering Center (ARDEC) Method, Picatinny Arsenal, New Jersey] is a thermal test used to determine the 5-sec time-to-explosion temperature of an energetic material. Apparatus used for this test includes a barricaded press with a die for loading 30 mg of energetic material into a no. 8 blasting cap, a no. 8 blasting cap crimper, a furnace with a molten Woods metal bath and shield, associated temperature measurement and controls, and a time interval recorder with microphone.

SAMPLE PREPARATION

A test sample is usually in powdered form. If need be, a material may be ground to a powder and passed through a 20-mesh screen before using in this test.

A no. 8 blasting cap (copper blasting cap: nominal 0.24 in outer diameter, 0.20-in. inner diameter, and 2 in. long) is placed in a steel loading fixture (die). Approximately 30 mg of sample is placed into the blasting cap. A copper 0.22 caliber gas check, open side up, is placed in the blasting cap. The gas check is pressed into the blasting cap at 6000 psi (230 lb force) for 10 sec. Approximately 30 mg of dried talcum powder is placed into the blasting cap. Another copper 0.22 caliber gas check, open side up, is placed in the blasting cap. The gas check is pressed into the blasting cap at 6000 psi (230 lb force) for 10 sec. About 25 no. 8 blasting cap are loaded for the test.

The loaded blasting caps were crimped at the closed end (explosive end) using a DuPont Superior Crimper, serial no. 1806.

The loaded, crimped blasting caps were stored in a wooden, non-propagating wooden tray.

WOODS METAL BATH PREPARATION

The woods metal bath consists of a steel cup, capable of accommodating a submerged no. 8 blasting cap, heated up to a maximum temperature of 500°C. The temperature of the Woods metal bath is set to the desired level. The temperature of the molten Woods metal bath is measured using a thermocouple and digital readout.

A loaded, crimped no. 8 blasting cap is placed in the Woods metal bath sampler holder. When the desired molten Woods metal bath temperature is attained, the loaded blasting cap is lowered into the molten Woods metal bath. The electronic timer is activated. When the blasting cap explodes, the timer is stopped using a microphone connected to the timer. The temperature and corresponding time to explosion is recorded. Successive tests (about 20 to 25 total) are performed in the same manner to obtain time-to-explosion temperature values over a time range of 1 to 7 sec.

ELECTRICAL CONTROL

The heating medium for this test is molten Woods metal that is contained in a Hoskins FD-10A heater with a copper crucible. Pictures of the system are shown in figures 1 through 3. A block diagram for this system is shown in figure 4. West Instrument Co. was the designer/fabricator of the control elements consisting of the controller and saturable reactor output unit. The controller has two modes of operation, manual and automatic. Because the original temperature sensor-indicator is broken and replacement parts are no longer available, the controller is operated only in manual mode using an Omega engineering temperature indicator. In manual mode, the test temperature is obtained by turning a control potentiometer to a predetermined setting that generates a control dc voltage that is applied to the control winding of the saturable reactor. This results in an output of the saturable reactor that is applied to the Hoskins heater to bring the Woods metal bath to the desired test temperature. That temperature is sensed by a type K thermocouple and indicated by the Omega temperature indicator.



Figure 1
West controller and saturable reactor

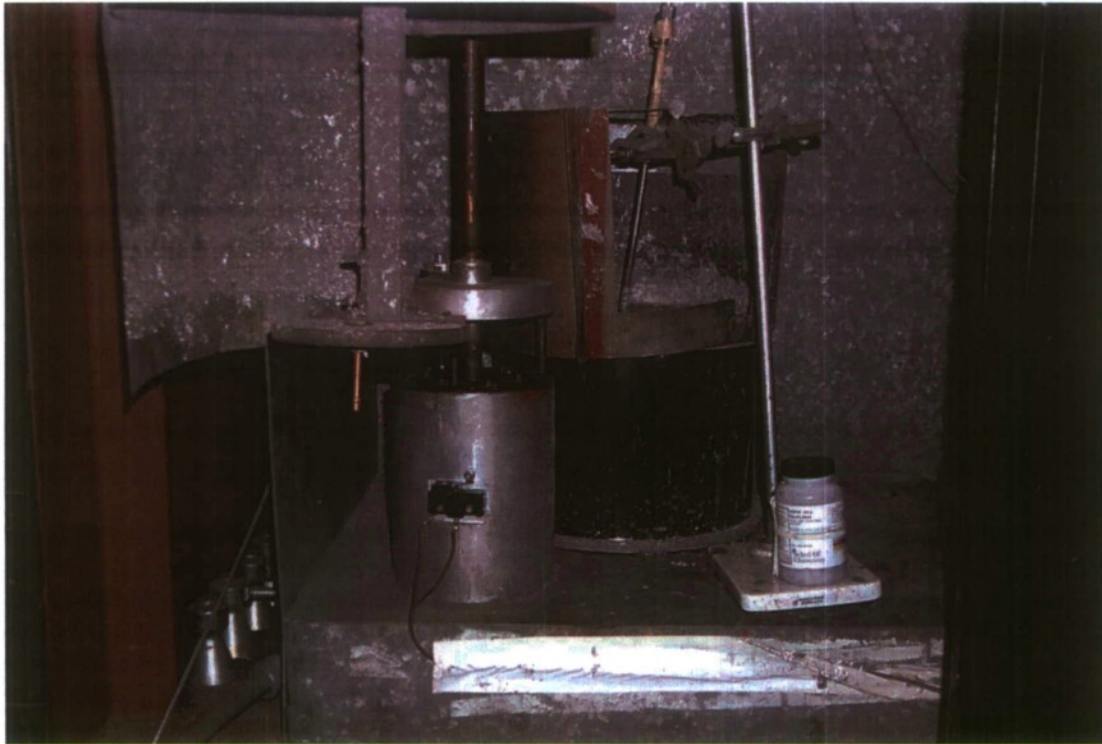


Figure 2
Hoskins FD-10A heater

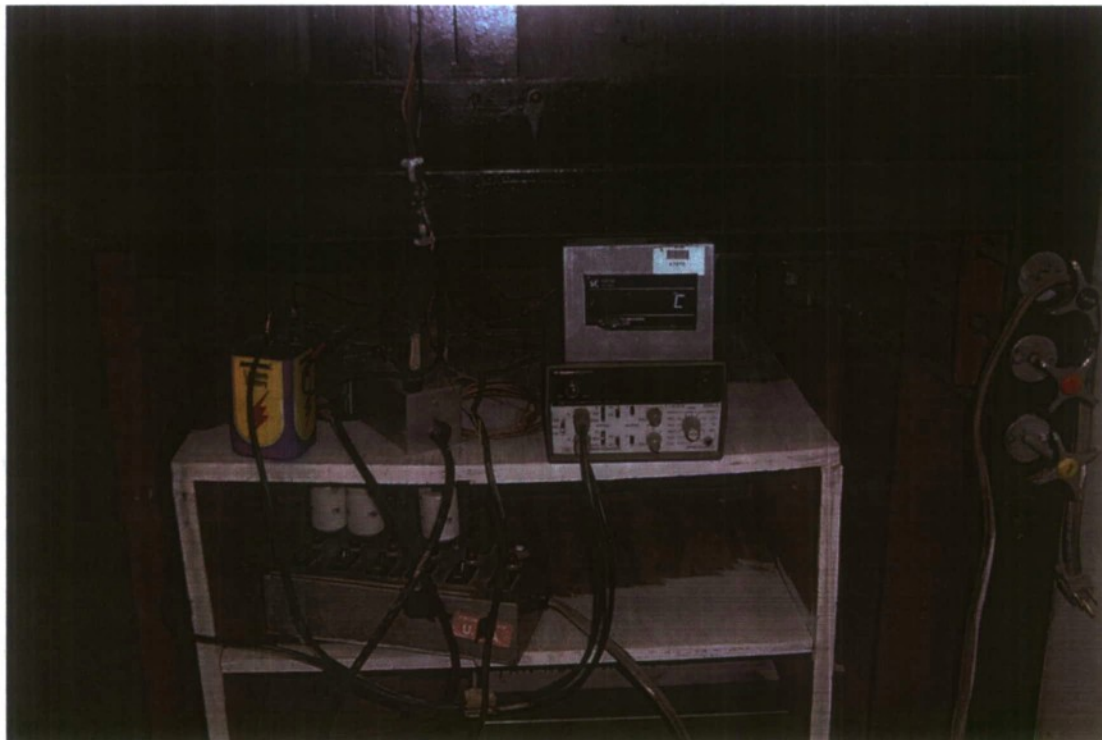


Figure 3
Omega temperature indicator and HP counter

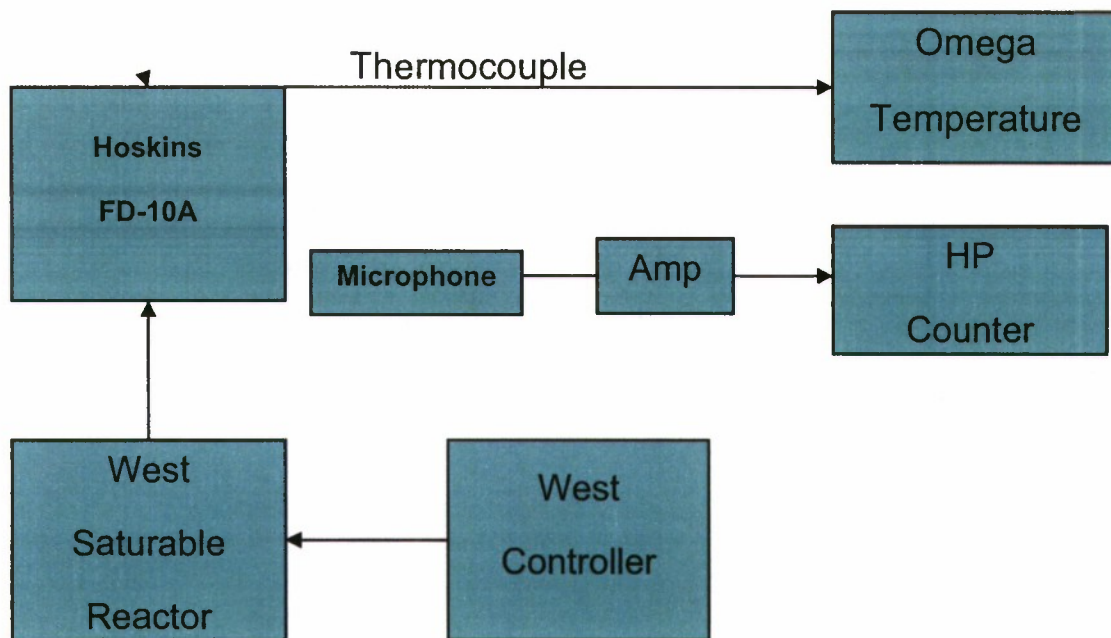


Figure 4
5-sec explosion temperature test block diagram

CALCULATIONS

The test result is reported as the temperature in degrees centigrade, which corresponds to the 5-sec time-to-explosion.

The test data are plotted as the natural logarithm of the time-to-explosion versus the reciprocal of the absolute temperature. This results in a straight line. A linear least-square curve fit program should be used to determine the temperature value for the 5-sec time-to-explosion. Microsoft Excel may be used to plot the data and determine the 5-sec time-to-explosion temperature of a material. Temperature and time data for class 1 RDX is given in table 1. A plot of this data is given in figure 5. A linear least-square curve fit program was used to determine the temperature value of 250°C for the 5-sec time-to-explosion for class 1 RDX.

Table 1
Temperature and time data for class 1 RDX

RDX type 2 class 1 Lot HOL93C517032	
Temperature (°C)	Time (sec)
297	1.02
293	1.19
287	1.07
284	1.66
284	1.58
283	1.54
282	1.62
281	1.37
280	1.66
277	1.94
276	1.99
256	3.87
248	5.42
247	6.04
245	6.43
244	6.29

5-sec explosion temperature = 250°C

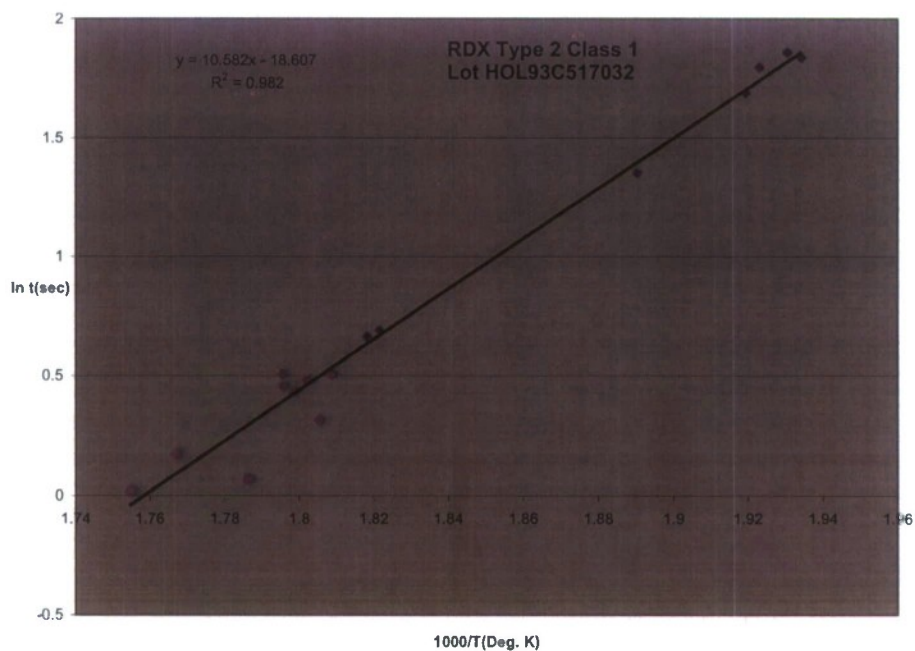


Figure 5
Plot of natural logarithm of the time-to-explosion versus the reciprocal of the absolute temperature for class 1 RDX

REFERENCE

1. MIL-STD-650, "Explosive: Sampling, Inspection and Testing," Interim Notice 4 (AR), 28 September 1987.

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U.S. Army ARDEC
ATTN: RDAR-EIK
RDAR-GC
RDAR-MEE-W (3)
Picatinny Arsenal, NJ 07806-5000

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ATTN: Accessions Division
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Chief
Benet Weapons Laboratory, WSEC
U.S. Army Research, Development and Engineering Command
Armament Research, Development and Engineering Center
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Watervliet, NY 12189-5000

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ATTN: ATRC-WSS-R
White Sands Missile Range, NM 88002

Chemical Propulsion Information Agency
ATTN: Accessions
10630 Little Patuxent Parkway, Suite 202
Columbia, MD 21044-3204

GLDEP Operations Center
P.O. Box 8000
Corona, CA 91718-8000